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Zero Retries is an independent newsletter promoting technological innovation that is occurring in Amateur Radio, and Amateur Radio as (literally) a license to experiment with and learn about radio technology. Radios are computers - with antennas! Now in its fourth year of publication, with 2400+ subscribers.

About Zero Retries

Steve Stroh N8GNJ, Editor

Jack Stroh, Late Night Assistant Editor Emeritus
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Web version of this issue - https://www.zeroretries.org/p/zero-retries-0185

Request To Send

Commentary by Editor Steve Stroh N8GNJ

Paid Subscribers Update

My thanks to **Prefers to Remain Anonymous 62** for *upgrading* from a free subscriber to Zero Retries to an **Annual Paid Subscriber** this past week! PTRA 62 said this:
High quality content, very applicable to where amateur radio data networks are now and are headed in the future. Don't get left behind.

Financial support from Zero Retries readers is a significant vote of support for the continued publication of Zero Retries.

Upcoming Events Countdown

HamSCI 2025, 2025-03-14 and 15, in Newark, New Jersey, USA in ***8 weeks***.

Tina KD7WSF and I are making plans to attend this event.

Store & Forward Podcast Episode 10

Our podcast about the past and future of ham radio by Kay Savetz K6KJN and I is now at Episode 10 - Store & Forward - Back to Work in 2025. Now available online to listen in a web browser, or in your preferred podcast app. At the Episode 10 page, there are copious show notes (gotta work on that succinctness - see below) and links to the major items we discussed.

These podcasts are a lot of fun, and because we hadn't talked to each other in a while because of our respective holiday breaks, we had a bit of catching up to do. Thus this episode is 1 hour long (could have been longer, but K6KJN applied some admirable editing).

My Three Stages of… Writing

In my career, I was sometimes involved in product development and there was a adage that there are three stages of product development:

1. Make it work.
2. Make it work *well*.
3. Make it work well, for *cheap*.

There was also an unacknowledged 4th stage - write the documentation, and 5th stage - prepare to support the product, but management and many coworkers didn't like to acknowledge Stage 4 and 5 as those were "overhead", not (sexy and appreciated) product development.

In my writing, I generally progress through three stages, and I was very aware of that process as I struggled with the articles in this issue to nail down the (new to me) concepts and details of the IP400 Project .

My stages of writing are:

1. Write about it *vaguely*. Get the general idea across.
2. Write about it *completely*. Explain all the (important) details.
3. Write about it *succinctly*. Distill it down to something between an elevator pitch and a 30 minute presentation.

Stage 3 is a continuing work in progress (challenge) for all my writing. I tend to write as I think / talk, and I work out my understanding of complex subjects best by writing about a subject or talking it through trying to explain a subject.

I also have some unacknowledged additional stages in my writing:

4. Copy each issue out of Substack (or other online editor) into an offline editor.
5. Create a static document of each issue as a PDF.
6. Get that PDF'd article into a secure archives (personal storage, plus upload it to DLARC).
7. Assemble multi-part articles into a single article (however long) as a PDF.
8. Repeat steps 5 and 6 for those PDF articles.
9. Add articles into the long deferred book as chapters.
10. Create a master index of unique subjects / articles mentioned in Zero Retries. (This one will only be doable with application of AI, and I just don't have time to teach an AI how to do this at the moment. With 3.5 years of weekly issues already published, it's effectively impossible - too time consuming - to attempt to do this manually.)

I have to work harder and more consistently on Stages 4-9 in 2025. And maybe *attempt* Stage 10.

Some of the current AI systems can do a decent job if you give it material at Stage 2. (If you give it material at Stage 1, it will just make stuff up.) So when you have the luxury of using AI as a reality check, sometimes you read the AI's summary and think "hmm… that *did* get the point across *with a lot less verbiage*" and perhaps that inspires you to to do better.

Or you could just "sub out" Stage 3 to Grammarly, which has been doing such things for years now, long predating the current publicly accessible AI systems. I know folks that won't let any of their writing out into public without first running it through Grammarly.

SuperPeater Part 4 in Work

Writing up the IP400 Project took precedence in this issue of Zero Retries over continuation of the SuperPeater series. Thus the next installment of the SuperPeater series is deferred for a few issues.

While there is overlap between my concept of a SuperPeater (and a related user radio that can take full advantage of the capabilities of a SuperPeater - *SuperRadio?*), there are some significant differences in scope between my SuperPeater concept and the scope of the IP400 Project as its creator VE6VH currently envisions it.

For example, I see considerable value in incorporating a separate Software Defined Receiver into the concept of a SuperPeater and especially a SuperRadio. Such SDRXs are not currently in the scope of the IP400 Project. So I'll keep plugging away at documenting my ideas of a SuperPeater, eventually to incorporate all of them into a special issue and a (long) explanatory article about it.

Future Project - A Directory of the Best Archival Packet Radio Material

Some disparate observations converged in my mind this past week:

- I read a great "looking ahead at the future of packet radio networks" in an old issue of 73 Magazine that I just obtained for my personal (paper) collection of 73 Magazine issues. There were good ideas in that article that still haven't been realized in this era. Keep in mind the most recent issue of 73 was *September, 2003!* I think that article should be re-examined for potential implementation in this era. That article is significant enough that it should be more widely known and shared.
- Kay Savetz K6KJN and I recently talked about how *much* material is flowing into DLARC almost every week… and how much *work* it is to get material into DLARC with at least minimal metadata. Kay (and Internet Archive in general) are working flat out to stay on top of the inflow to DLARC and IA.
- Billy Penley KN4MKB's (Modern Ham YouTube channel, Modern Ham blog) most recent article - The Hard Truth about Hardware TNCs in Packet Radio is still running around in my head - it was an excellent article. Perhaps he, and perhaps readers of that article could benefit from some of the excellent material about Packet Radio that was written when packet (and especially, Packet Radio networks) were still active and evolving such as detailed explanations of using legacy (hardware) TNCs that folks try to use today, and struggle with.
- Now that we're beginning to be able to rethink old Amateur Radio repeater and networking paradigms with IP400 (discussed in this issue)… it might be good to reexamine what we did regarding Amateur Radio networking in the past that worked, like TEXNET which has been mentioned a few times recently in Zero Retries. But it's hard to find such articles.
- There are many times I want to reference something significant from an archive, but I haven't bookmarked it effectively, and so I have to waste time to search for it to get a link to it that I can use in Zero Retries.

A few conclusions of this convergence of thoughts:

- Many excellent books, magazines, and articles about Packet Radio that are now long out of print, and are thus unobtainium (except for ridiculous "vintage" pricing on eBay) are now available, free to access, in DLARC.
- The problem is that even though these great materials do exist in Internet Archive / DLARC… it's often damn tough to find them when you don't know an exact title. For example, typing "Packet Radio Book" in DLARDC doesn't show you *books* with *Packet Radio* in the title… you're shown 69 items… none of which are a book on Packet Radio.
- Kay, DLARC, and Internet Archive in general are all saturated doing what they do so well - scan, process, and make archival material available online. As much as I'd love to think of DLARC as a great repository for *Packet Radio* material, DLARC represents *all* of Amateur Radio. There's probably 10x or more material in DLARC about DXing and contesting than there is about Packet Radio. Thus asking DLARC / IA for a "Packet Radio Index" is (quite reasonably) out of their scope.
- Having been involved in Packet Radio since the early TAPR TNC2 days, I have a perspective of what good Packet Radio material that *is* out there in DLARC, that's relevant and still useful. I also have a head start as I have a bookshelf full of Packet Radio books in my personal collection. I had duplicates of most of them that I either donated to DLARC, or someone else already had. Thus I know the titles, and can find them in DLARC more easily than most people can.

Thus, to develop a reasonable Index of significant material about Packet Radio that's available in IA / DLARC…

"If it is to *be*, it's probably up to *me*" would seem to apply.

Thus I'm going to start yet another project to build such a thing. Not to mention, ***I*** *need such a tool* for my work here in Zero Retries.

It won't be a huge project. I'll start it in a document and populate it as it occurs to me and I have time to add to it. Nothing fancy… but reasonably easy to navigate. For example:

> **Books**
>
> - **PACKET RADIO** by Robert Roleau VE2PY and Ian Hodgson VE2BEN, 1981
> *First book that specifically discusses Amateur Radio Packet Radio from the early conceptual stage in Montreal, Quebec, Canada.*
> - **Packet Radio Primer** by Dave Coomber G8UYZ and Martyn Croft G8NZU, 1991
> *Some differentiating detail that I learned after at least scanning through the book.*

Magazines / Newsletters

- Packet Radio Magazine
- TAPR Packet Status Register

Standards / Research Papers

- Computer Networking Conference x
    - Listing of papers presented at that conference

Significant Articles

- ~~The article in 73 that I mentioned earlier~~
  (**Post publication update** - I was asked about this article in the comments, so here it is.)
  Beyond Level Two - High-level networking comes to packet radio
  Phil Karn KA9Q
  73 Magazine, August, 1986, pages 74-78
  https://archive.org/download/73-magazine-1986-08/08_August_1986.pdf
- Articles about PACSATS
- How the KISS protocol interface came to be and why it's so comparatively poorly designed (it was a quick hack, intended to be temporary).

You get the idea.

Again, everything in this index will be accessible, for free, worldwide, in Internet Archive / DLARC.

I'm imagining putting this index at an easy to remember domain name (that I'll pay for at least a decade in advance). There are various ways to do a simple static web page and get it hosted at no cost. Perhaps this is even a candidate for a wiki.

Please share your thoughts.

Every Project Needs…

I'm sure that this subject has been exhaustively dissected, and there are probably entire books written about the critical elements that every project needs to succeed. But I'm watching a number of Amateur Radio projects from my perspective of Zero Retries, and I'm also involved in a few. This is *Amateur Radio*, a bit of a unique niche of society (and definitely not attempting to be commercialized for big profits). Thus my observed requirements for successful projects are a bit different from commercial projects.

This isn't an exhaustive, detailed treatment, but just a few thoughts that I'll add to periodically.

- A developer with a good idea and the ability to execute the idea.
- A web page explaining the project. It doesn't have to be any more complex than an online equivalent of a brochure.
- A cool looking logo helps a lot. That's getting easier thanks to free AI tools that you can just describe what you have in your imagination, and quickly iterate.
- If the idea is a complex one that is hoped to last for multiple years, an organization behind the developer is needed to spread the workload and provide a formal structure. Paid membership in the organization is a way to help fund development costs.
- If it's a complicated project, some way of funding development and production. Financing is getting more and more accessible with "storefronts" to accept payment, crowdfunding like Kickstarter and Crowd Supply, and grants from ARDC.
- An online community. I prefer groups.io email lists. Lots of folks prefer Discord. Something… *consistent*… that isn't under machiavellian control / influence.
- Reliable testers to beat up on the prototypes / beta versions and report back. *Reliable*, trusted testers who can observe carefully and communicate issues in writing. Otherwise the developer has to put too much of their limited attention and time into such testing.
- A documentarian who is willing to write at least minimal documentation for the project on how to use the device or system. One stellar example is the excellent documentation available for the various fldigi modes.
- ***Most importantly***… an evangelist who's willing to get out in front of the project and do interviews on YouTube channels, podcasts, and articles, do online presentations at club meetings when asked, staff a table and answer questions at major Amateur Radio conferences… and generally represent the project well and consistently. Sometimes the developer chooses to assume this role, but that divides their attention. In imagining this role in a project, I'm thinking specifically of the role that Orv Beach W6BI provides as "AREDN Ambassador" for the AREDN project. I believe that AREDN would not be nearly the success that it is without the very active role and focused, hard, consistent work of evangelizing AREDN that W6BI does so well.

Have a great weekend, all of you co-conspirators in Zero Retries Interesting Amateur Radio activities!

Steve N8GNJ

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Introduction to the IP400 Project - VE6VH

By Martin Alcock VE6VH

I have been a radio amateur for many years, and in that time, I have always had an interest in the higher frequencies and have built several repeater controllers. In the last couple of years I designed an FPGA based controller that is now running two local 900 MHz machines, and recently started working on the next generation.

In analyzing the requirements not only for control but for communication with other repeaters, it became apparent that the existing methodology is leaving out many new modes that have evolved in recent years. The introduction of continuous envelope 4-level frequency modulation (C4FM), which has given rise to radios under several brand names that use digital voice coding and are also data capable. Requirements for other data streams such as position reporting, which is stuck using an obsolete modem technology, as well as telemetry, and messaging all point to an intra-repeater methodology that is digital.

There are several digital networks that have arrived in the amateur scene which are suitable for repeater connection, such as AREDN, HamWAN and New Packet Radio. AREDN has the advantage of mesh networking, which has more than one path between two stations, thus providing a built-in facility to provide a backup path should one fail. It is also an 'ad hoc' network, which means there is minimal administration required to get on the air. HamWAN is a static network (albeit with redundant links / failover capabilities).

However, AREDN and HamWAN are limited to repurposed commercial devices that are not only low power but run in bands available to the public where amateurs had secondary privileges. New Packet Radio does run in the amateur 420-450 MHz band but requires an administrator and utilizes a polling technique which occupies valuable bandwidth. Taking the best of each, a suitable network should run in the 70cm band and preferably utilize an 'ad hoc' mesh topology, to simplify joining the network and routing between stations.

The AREDN network came about due to advances in the commercial arena created by the Institute of electrical and electronic engineers (IEEE) 802 standards for local, personal and wide area networks. We are all familiar with the 'blue cable', which is based on the 802.3 standard. The first number refers to the standard, the second refers to the medium upon which is implemented. The popular Wi-Fi standard is based on 802.11, and there are more beyond that.

The chip manufacturers, such as Microchip, Texas Instruments and STMicroelectronics are building inexpensive radio chipsets based on these standards, which are utilized in consumer applications such as remote meter reading and have a relatively high power output at 100mW. Most of these operate in the 900 MHz and 2.4 MHz ISM band allocations, but some also can operate in 420-450 MHz.

With a digital mesh platform to replace conventional analog links the possibilities are endless. Not only can they carry digital data such as compressed audio and telemetry, but also have the capability of transmitting compressed digital video. However, it is not limited to those applications, as a general replacement for AX.25, it can also encompass position reporting, chat modes, and bulletin board systems of the past could be revived.

To solidify the on-air presence requires the physical layer be defined at an early stage, which will determine a modulation method, data rate and frame format. From there suitable hardware can be found to deploy it. One of the specifications of interest is 802.15.4 for low rate wireless networks, where the low refers to data rates below 1 Mbps. Several IOT (Internet of Things) chip and module manufacturers have adopted this standard, and inexpensive parts are available off the shelf.

One of the most powerful experimental tools available to the radio amateur is the Raspberry Pi computers, which are feature rich and affordable, and is at the heart of many applications. These have the capability of the addition of a HAT (Hardware Attached on Top), where application specific modules can be mounted. A simple station to get on the air can be fabricated from one of these, and there are power amplifiers commercially available that increase the low power output of the radio chipsets to 20W or more, and the possibility of a home brew amplifier still exists. The more recent Raspberry Pi 5 has a built-in video codec as well based on the H.264 standard.

I have obtained some IOT modules that feature the STMicroelectronics STM32WL33, a newly announced chip that supports the (802).15 frame format and are inexpensive. There are off the shelf development boards available for them now at most distributors, and a Raspberry Pi HAT is in development which should work from the Raspberry Pi Zero up to the Raspberry Pi 5. The rest, as the saying goes, is software. And on that note, there are SDR modules also commercially available that can be used; however, I have not explored that route yet.

We have a ground floor opportunity to develop our own mesh network in the 420-450 MHz band that can be used for many different applications, the limit of which is the imagination alone. The first step is to get a simple chat and beaconing application running to experiment with the technology. From there we can layer on other features and frame types, and then consider moving into the repeater world. To give the project a name, it has been dubbed 'IP400', for Intelligent (not Internet!) Protocol.

I would like to invite you to join the project effort, at this point we will be brainstorming how we would use it, and then that will be distilled into a specification. The software will, of course, be open source and freely available, developers in the C and C++ languages are welcomed to contribute.

To contact me directly, use my contact page.

I have established a discussion group at ip400@groups.io, fee free to join it, even if you are not a developer. See you there.

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Introduction to the IP400 Project - N8GNJ

By Steve Stroh N8GNJ

My personal perspective on the IP400 Project.

Longer term readers of Zero Retries know that I've dreamed / speculated / opined about a Software Defined Transceiver that's designed for Amateur Radio use on Amateur Radio VHF / UHF bands (that transmits reasonable power - 10 watts, minimum). My vision, briefly, is a black (or blue, or whatever) box with four connectors: power, antenna, USB (-C these days), and Ethernet. Controls are equally minimal - a few indicators for basic health, such as PTT, TX, PWR, and ???. The switch is for power and perhaps a second switch for inhibiting transmit for testing out new software. All "controls" for the radio would be a text console or a web page on a remote computer

My first glimmer that such a unit might become reality was the Northwest Digital Radio UDRX-440. For many (reasonable) reasons, that radio wasn't to be.

Another hoped for Software Defined Radio for VHF / UHF was the RPX-100, a project by the Austrian Radio Amateur Society (OEVSV) funded by a grant for ARDC to develop a Software Defined Radio for 50 / 144 / 440 MHz. That project, for unknown reasons, also wasn't to be.

I've continued my quest for such a radio.

I first encountered Martin Alcock VE6VH from a presentation he created for the Alberta Digital Radio Communications Society (ADRCS) that was inadvertently shared in December 2023 on a public email list. I was impressed by the vision expressed in the presentation of extending the paradigm of Amateur Radio Emergency Data Network (AREDN) with *designed-for-purpose radio units for Amateur Radio*. (AREDN is currently replacement firmware for outdoor Wi-Fi and Wireless Internet Service Provider - WISP units operating on license-exempt portions of spectrum). VE6VH and I further bonded over one of his previous employers that I had visited during my earlier career of writing about Broadband Wireless Internet Access. Knowing VE6VH's background of designing radios for that former employer, *I had no doubts* that VE6VH had the requisite skills to accomplish what he was proposing to build in that presentation.

VE6VH and I reconnected recently after he read my evolving concepts of a SuperPeater (Part 1, Part 2, Part 3) and my descriptions of a user radio that would be able to take full advantage of the capabilities of a SuperPeater. My concepts for both the SuperPeater and the "SuperRadio" coincided with his ideas, which had progressed in the year since we last corresponded. VE6VH was now working on a flexible and versatile VHF / UHF repeater controller / link unit, and…

a Software Defined VHF / UHF Radio for users!

VE6VH has named the project **IP400** - **I**ntelligent **P**rotocol operating on the **400** MHz band.

From my perspective, I am encouraged that a number of factors regarding IP400 have aligned that make it more likely than usual for such a project to become reality:

- VE6VH has the requisite design skills with digital hardware, RF hardware, FPGA coding, software, PCB design, etc.
- There is an organization backing his work to create IP400 - Alberta Digital Radio Communications Society (ADRCS).
- VE6VH is, where possible, basing IP400 on *existing* chipsets, protocols, software stacks. For example, radio chipsets, digital voice protocols using the open source MMDVM code, the 802.15.4 standard , Linux running on Raspberry Pi, TCP/IP, Ethernet, etc.
- VE6VH has an established relationship with a commercial vendor to manufacture assembled and tested units at sufficient scale to supply anyone interested. There will also be some versions of hardware made available as kits.
- All elements of IP400 will be made available as open source.

Thus I have agreed to actively support the IP400 project as a contributor to the overall design, specifications, testing, documentation, and evangelism.
Disclaimer - ADRCS has granted me an honourary membership in response to my contributions to the IP400 Project. I have no role in managing ADRCS.

At *this* moment - January, 2025, admittedly early in the project, IP400 remains largely conceptual. VE6VH has built a number of prototype hardware units, with some functioning software, sufficient to convince me that IP400 will gather momentum and result in usable hardware.

I'm optimistic that some elements of IP400 could become a reality in a reasonable timeframe such as by year end 2025.

Leave a comment

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Background and Details on the IP400 Project

By Martin Alcock VE6VH and Steve Stroh N8GNJ

IP400 is Inspired by and Interoperable with AREDN

In an ideal world (and is actually the case in some areas, such as Southern California), the ideal "2020s and beyond" Amateur Radio data infrastructure would be based on Amateur Radio Emergency Data Network (AREDN) Access Points (APs) and user / mesh nodes. AREDN APs are network nodes equivalent to VHF / UHF repeaters in that they are generally located on high profile locations such as mountaintops, communications towers, rooftops, etc.). User / mesh nodes are equivalent to packet radio such as an individual's packet radio station can provide a digipeater service to nearby stations.

AREDN provides high speed data communications (> 100 Mbps in many cases) using the TCP/IP protocol (same as the Internet). Thus nearly any service that operates on the Internet can also be used on an AREDN network. Examples include videoconferencing, high resolution video cameras, Voice over Internet Protocol (VOIP) telephones, web servers (and browsers), email servers and email clients, etc.

But in many cases, using AREDN is problematic because AREDN firmware / software is only available for selected Wi-Fi and Wireless Internet Service Provider (WISP) radios that operate only on the 2.x GHz band and the 5.x GHz *microwave* bands. Thus AREDN users without clear (optical) line of sight to an (high profile) AREDN AP or a nearby User / Mesh node may find AREDN unusable.

If… AREDN could be adapted for use with the Amateur Radio 420-450 MHz band, such an adaptation could be the "best of both worlds":

The advantages of 420-450 MHz:

- Relatively unaffected by trees,
- Does not require absolute optical line of sight paths,
- Transmitting reasonable power levels - 10 / 25 / 50 watts is relatively easy and inexpensive.

and

The advantages of AREDN:

- High speed data (but not nearly as fast as what's possible on 20 MHz microwave channels),
- Use of TCP/IP,
- Automatic mesh networking

IP400 fits into a network hierarchy with AREDN:

1. AREDN Supernodes interconnected to other AREDN Supernodes via Internet.
2. AREDN Supernodes connecting multiple AREDN radio networks.
3. AREDN Radio Networks utilizing Access Points and User Nodes
4. AREDN User / mesh nodes
5. IP400 repeaters and user nodes
6. IP400 user nodes communicating between themselves, optionally providing mesh networking.

The goal, generally, of IP400 in relation to AREDN is for an IP400 repeater or station to be "just another node" in an AREDN network. Ideally,

- IP400 repeaters, nodes, or services on an IP400 network or node are visible on an AREDN map and accessible from an AREDN network.
- AREDN APs, AREDN user / mesh nodes, or services on an AREDN network or node are visible on an IP400 map and accessible from an IP400 network.

General Goals of the IP400 Project

The IP400 Project is designed to modernize Amateur Radio VHF / UHF repeater infrastructure and, in parallel, create a new generation of software defined VHF / UHF ***user*** radios for the mid-2020s and beyond.

IP400 is not intended to *replace* current digital voice or analog FM Amateur Radio repeaters. Use of IP400 technology is *not* an either / or choice of maintaining current digital or analog FM repeater capabilities *or* requiring the new capabilities of IP400. IP400 is designed to *add* additional capabilities and utility to existing (or new) repeaters, making them more useful and implementing state-of-the-present digital / data technology. Whenever possible, IP400 provides backward compatibility with existing Amateur Radio standards and systems.

Primary features of the IP400 project include:

- Backwards compatibility with current and future (M17) digital voice systems, as well as analog FM, through the use of Multi Mode Digital Voice Modem (MMDVM) technology.
- Incorporation of data communications including telemetry, APRS, short messages, bulletins, APRS, file transfers, email, digital video, etc.
- Advanced repeater-to-repeater linking on Amateur Radio VHF / UHF bands using a data link that will accommodate high quality voice and data.
- Based on modern technologies such as Linux, TCP/IP, Asterisk (AllStarLink), 802.15.4), Raspberry Pi computers, Ethernet, high data speeds (minimum 600 kbps), etc.
- All hardware will be software-based and easily upgradable (use of FPGAs, embedded processors), and designed for future expansion.
- The **Multi-Mode Digital Link Controller (MMDLC)** for repeaters is in advanced development. It provides two audio interfaces for connection to analog or C4FM-based repeaters, and has the M17 codec built-in. It incorporates a 100 mW radio operating on 420-450 MHz (with interfaces to use a power amplifier when needed). For repeaters that are colocated, multiple MMDLCs can be linked together via Ethernet. A goal of the MMDLC is to eventually incorporate all contemporary repeater controller features. Users do not require a Multi Mode Digital Link Radio (see next item) to use a repeater with an MMDLC. For example, a user with a conventional digital voice radio, or a radio using a modem for selected data modes can connect to a repeater with an MMDLC.
- The **Multi Mode Digital Link Radio (MMDLR)** is a user radio based on the same architecture as MMDLC, thus it also incorporates a 100 mW radio operating on 420-450 MHz (with interfaces to use a power amplifier when needed). The usage and utility of the MMDLR does not depend on connecting to a repeater with an MMDLC. For example, the MMDLR can operate as a conventional digital voice radio to connect with a digital voice repeater. The MMDLR is in early design and it is expected that it will be available in 2025. Some MMDLR units will be available as kits, other units will be available assembled and tested.
- To restate, it's not required to use both a Multi Mode Digital Link Controller (repeater) together with a Multi Mode Digital Link Radio. Either unit will function with existing Amateur Radio modes and systems. But when used together, the synergies are powerful… such as the (potentially) MMDLC being able to tell MMDLR stations what its most powerful and fast capabilities are, and then MMDLR stations can operate at that higher level of performance.

Ambitious Goals and Requirements of IP400

The concepts, specifications, protocols, etc. of IP400 are still being defined, but care is being applied during the definition phase insure that no element of IP400 will "fossilize" any technological choice that would prevent technological evolution of IP400. Examples of looking ahead:

- Not requiring use of specific data modes,
- Offering a choice of digital voice systems,
- Use of code written to be portable so that it can be ported to various processors, FPGAs, or other hardware components,
- Use of standardized software interfaces (APIs) and standardized hardware interfaces such as IIC,
- Use of Linux (the most widely used, and widely ported OS),
- All software and hardware designs offered under open source license,
- No technical choices tying IP400 specifically to any specific Amateur Radio band. Choice of Amateur Radio band. Regarding "IP***400***", the use of the Amateur Radio 420-450 MHz band is a pragmatic choice to begin development of the IP400 project as there are a variety of highly capable, widely available, and reasonably priced radio chipsets available for use on the Amateur Radio 420-450 MHz band.
- IP400 is designed to be flexible, extensible and is not limited to the current / near future MMDLC or MMDLR hardware..

Sponsoring Organization - Alberta Digital Radio Communications Society (ADRCS)

Alberta in Western Canada is a largely rural province with two urban areas - Calgary and Edmonton separated by approximately 300 km. Alberta's terrain is largely flat, and sparsely populated, which makes locating Amateur Radio repeaters, and linking them via radio, challenging. Conversely, Alberta's flat terrain makes high profile repeaters (when possible) an ideal solution for linking between Amateur Radio stations. Current repeater linking networks in Alberta are either via commercial Internet or cellular, or via Amateur Radio analog links.

ADRCS - About Us:

> The Alberta Digital Radio Communications Society was formed in 2022 to promote the use and develop new technologies using digital communication in Amateur Radio. It is the sponsor of the AREDN network in Western Canada, in the time since its inception it has grown from a single node to a network that spans the province, and includes the NW Territories, Eastern BC and parts of Northern Montana.
>
> The society has developed several server-based applications on the network, including weather information gathering and dissemination, secure e-mail, telemetry and others. For more information visit the applications page on the site.
>
> Recently the society has started an effort to bring ad-hoc networking to the UHF bands, using off the shelf components that conform to the 802.15.4 standard. This project is in its inception, and we welcome participation. For more information see the IP400 Networking page.

ADRCS is the organizational sponsor of IP400 conceptual, hardware, and software development. ADRCS's organizational structure allows the receipt of grant funding for IP400 development work and other expenses.

Help Needed / Development / Coordination

These specific skills are needed / requested for development of IP400:

- C and C++ software development
- STMicroelectronics development platform
- Digital radio design and development
- Verilog
- PCB design
- Amateur Radio protocol developers (for developing backwards compatibility of existing Amateur Radio modes, especially data modes)
- Radio frequency power amplifier design

Resources / Further Information on IP400

- **Web page** for the IP400 Project - https://adrcs.org/adrcs/ip400-network-project/.
- **Email list** - ip400@groups.io.
- ~~**GitHub Repository -** https://github.com/vc6vh/ip400.~~
  (Post publication update)
  GitHub Repository - https://github.com/adrcs/ip400.
- ~~**IP400 On-air Protocol Specification, Revision: 0.1** is available for IP400 contributors.~~
- ***(Post publication update)***
  IP400 Protocol R0.3

First Public In-Person Demonstration - Pacificon 2025

It is hoped that VE6VH and N8GNJ (and perhaps other contributors) can attend Pacificon 2025 in San Ramon, California, October 10-12, 2025. We hope to offer a seminar on the background and progress of the IP400 Project and have a table to discuss and demonstrate IP400 hardware and software.

Future Installments on IP400

There will be future articles on IP400 here in Zero Retries as development of IP400 and its various sub-projects such as the MMDLC and MMDLR hardware evolve.

For more realtime information on the progress of IP400, we suggest joining the IP400 email list (linked above).

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Imagining an HF Appliance Based on the zBitx

By Steve Stroh N8GNJ

The announcement of the HF Signals zBitx portable HF radio has stimulated some thoughts about an HF "appliance" based on my earlier thoughts about a VHF / UHF data appliance.

For me, the recent announcement of the zBitx, and its overall architecture, was a refreshing departure from the usual low power portable HF radios that are designed mostly for analog modes, and the multi $thousand HF radios that are "Software Defined".

It was also refreshing that unlike almost all HF radios, the zBitx treats data / digital modes as "just another mode" along with traditional analog modes. This acceptance of data / digital modes allows the zBitx to work better than the 5 watt transmit power would otherwise suggest. One example is zBitx's inclusion of the FreeDV digital voice mode designed specifically for the vagaries of HF. With its advanced modulation, and inclusion of Forward Error Correction, FreeDV can work better, and more reliably, at 5 watts transmit power, than analog voice modes at 5 watts transmit power. And, experimentally, there is also the FreeDATA mode which leverages the extensive development of FreeDV, but instead of a voice payload, FreeDATA has a data payload. "It's just software" so FreeDATA can easily be added into the open architecture of the zBitx. Each mode to be used on the zBitx is stored on the MicroSD card, and then loaded (one mode at a time) into the Raspberry Pi Zero for use.

Two things leaped out at me about the zBitx that stoked my imagination:

- It's software and hardware designs will be released as open source,
- It's built largely around a Raspberry Pi Zero so the RF section is minimal.

So what if there was a "fork" of the zBitx technology into a (non-portable) HF radio appliance? Imagine a low power HF radio that could be installed into an attic along with a minimal antenna (for total stealth mode operation). Or imagine a low power HF radio that could be installed into a small utility box and mounted on pole with an HF vertical antenna or a magnetic loop antenna for a "small footprint" installation in a small back yard or an apartment balcony.

Some potential features of such a "fixed" variant of the zBitx:

- No local controls - knob, display, etc. All operations are 100% remoted to a "console" computer - laptop, tablet, etc.
- Since size isn't a factor for the fixed zBitx, a larger Raspberry Pi could be used. Since HF Signals says that the Raspberry Pi Zero has ample processing power for the zBitx, a Raspberry Pi 3 should work fine and doesn't require external cooling such as a big heatsink or fans.
- Potentially the fixed zBitx could be powered by Power Over Ethernet (POE). Or not - POE may generate too much radio frequency noise in the HF band. Or just utilize the power system in the zBitx - operation from two 18650 Li-ion batteries or a 9 volt input (for remote use, an "RF quiet" 12 volt to 9 volt step down regulator could be used).
- Another advantage of POE operation is that the Raspberry Pi can be booted from Ethernet from a boot file on a remote computer. This would make updating software on the Pi very easy.

Thanks to the inclusion of the Amateur Radio 10 meter (28 MHz) band in the zBitx, the zBitx could increase interest in HF operations by US Technician class operators. Their operating privileges include some some voice and data operation on the 10 meter band (28 MHz):

- 28.0 - 28.3 MHz can be used for data communications by Technicians.
- 28.3 - 28.5 MHz can be used for voice communications (including FreeDV) by Technicians.

In addition, 10 meter antennas are of reasonable size and simple to construct. For comparison, the Citizens Band is at 27 MHz, and antennas for CB are plentiful and inexpensive.

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ZR > BEACON

By Steve Stroh N8GNJ

Short mentions of Zero Retries Interesting items.

Computing Across America Serialization (Newsletter)

My friend Steven K. Roberts (now N4RVE) has begun serializing his book Computing Across America (which has long been out of print) in periodic installments via a free Substack newsletter.

> I'm a paleo-geek who digitizes ancient media in a mobile lab parked on San Juan Island. In the '80s, I pedaled 17K miles on a computerized recumbent bicycle as the first digital nomad, and am now publishing the tale of that decade.
>
> Never miss an update—every new post is sent via email. This is the full story of 17,000 mi of high-tech nomadness, spanning three bicycle versions and nearly a decade (with lots of photos and geeky detail).

The initial version of N4RVE's "bicycle" featured a CB radio, but the next revision (Winnebiko) included Amateur Radio VHF and Packet Radio. The final version (BEHEMOTH) featured a trailer with Amateur Radio HF, satellite, and television capability, and an interesting hack for email communications via satellite. I have one of the (rare) copies of Computing Across America that I've re-read several times, and this serialization is still interesting as N4RVE is adding some commentary, photographs, etc. without detracting from the tone, and the historical context of the original book. Recommended!

Vanishing Culture: Digital Library of Amateur Radio and Communications

Great article for a general audience on the Internet Archive blog by DLARC Archivist (and great friend to Zero Retries, and a Zero Retries Pseudostaffer) Kay Savetz K6KJN:

> *The following guest post from curator and amateur radio enthusiast Kay Savetz is part of our Vanishing Culture series, highlighting the power and importance of preservation in our digital age.*
>
> Amateur Radio has been a hobby for well over 100 years. For as long as there has been an understanding of electricity and radio waves, people have been experimenting with these technologies and advancing the state of the art. As a result, the world has moved from wired telegraphy to tube radios to telephones—fast forward a century—to GPS and high-speed digital communication devices that fit in your pocket.
>
> Advances made by amateur radio experimenters have propelled the work of NASA, satellites, television, the internet, and every communications company in existence today. People fiddling with radios have pushed forward technological advances the world around, time and time again.
>
> And yet, the people making these efforts, doing these feats, aren't always the best at documenting and preserving their work for the future. That's where Internet Archive comes in.

Now that the infrastructure and processes of DLARC have been established within Internet Archive over the past couple of years, the largest task ahead of DLARC for the immediate future is continuing to "get the word out" *that DLARC exists*, not just as a resource of free online Amateur Radio material, but as a destination for individual's Amateur Radio material that "needs a good home". Invaluable Amateur Radio material is literally being lost every day as Amateur Radio Operators die and their carefully collected Amateur Radio material is unceremoniously dumped into the recycle bin - because very few people within Amateur Radio, and families of Amateur Radio Operators know about DLARC as an option for donating collections of Amateur Radio material.

Please help spread the word about DLARC within your circles - local clubs, families of recent Silent Keys / Keyboards, organizations you participate in, etc.

Project MINI RACK

Jeff Geerling (KF0MYB) on his blog and YouTube channel:

Today I'm announcing Project MINI RACK, an open source project to help those building homelabs, RF/wireless rigs, and other electronics projects into mini 10" racks.

Not everyone can afford (either due to budget or space constraints) to have a full 19" rack in their home. Besides that, people may want to deploy small, easily-composable equipment racks to remote sites, or have one in the car that they can take anywhere! And with the flood of Mini PCs in the market (in addition to SBCs and small PoE-powered network devices), and the move to solid state storage, a mini rack can hold a formidable amount of resources.

The r/minilab subreddit is probably the largest nexus of mini rack enthusiasts—and Project MINI RACK doesn't aim to supplant that. But I would like to have a central resource for 10" rack mount equipment, racks, and compatibility testing.

Some ideas just “click” with you the moment you see them, and that was the case with me as soon as I saw this article by KF0MYB. The MINI RACK form factor just makes *so much sense* as a physical standard to integrate today’s smaller electronics units into an organized *system*.

I’ve seen other “mini” (desktop) racks built by Amateur Radio Operators to integrate a stack of radios, modems, power supplies, etc. into a single unit. But each one is unique, with no standardization, widely varying utility and ability to reproduce them, etc.

One great example of a well-built customized mini rack for Amateur Radio is the one built by Jeffrey Komori KH6JUZ. He designed (and tested) and built (and rebuilt) his own Amateur Radio min rack system to accommodate four radios, four modems, a Raspberry Pi, power distribution, etc. Those racks are to support KH6JUZ’s project to improve APRS coverage on the island of Oahu, Hawaii, USA with a network of these units providing APRS service on 144.39 MHz at 1200 bps, and 9600 bps APRS service on the 144, 222, and 440 MHz bands. For more details, including a photo of KH6JUZ’s rack, see **Zero Retires 0171** - A 144 / 222 / 440 MHz 9600 APRS Stack… and Network!

Thus what makes the MINI RACK format that KF0MYB is promoting so much better, to me, for Amateur Radio use is that (I think) it will very quickly catch on with the very large (much larger than Amateur Radio) community of homelab enthusiasts. With that large of an audience, compatible (and value priced) products will quickly emerge.

With KF0MYB, or as he’s much better known, Jeff Geerling getting out in front of this trend not just with this mention, but a dedicated resource page for the project: **Project MINI RACK**, I think that the MINI RACK trend will quickly become very popular.

The MINI RACK format has immediate utility for me because I am working (slowly… *slowly*…) towards building up various radio / modem / computer combinations for testing and demonstrating various Amateur Radio data systems. My first such project is integrating a 222-225 MHz radio, a modem, and

a mini PC to test and demonstrate how well VARA FM actually works. Putting the two units that I'll be building up in a MINI RACK is an immediate solution to that issue.

One MINI RACK item I hope to see is a drawer in the MINI RACK format to contain all the disparate "bits and bobs" that accompany such a system, such as multiple SD cards, cable adapters, etc.

Forgotten Internet: UUCP

Good Hackaday article by Al Williams:

> What's Forgotten Internet? It is the story of parts of the Internet — or Internet precursors — that you might have forgotten about or maybe you missed out on them. This time, we're looking at Unix-to-Unix Copy, more commonly called UUCP. Developed in the late 1970s, UUCP was a solution for sending messages between systems that were not always connected together. It could also allow remote users to execute commands. By 1979, it was part of the 7th Edition of Unix.
>
> Operation was simple. Each computer in a UUCP network had a list of neighbor systems. Don't forget, they weren't connected, so instead of an IP address, each system had the other's phone number to connect to a dial up modem. You also needed a login name and password. Almost certainly, by the way, those modems operated at 300 baud or less.
>
> If a computer could dial out, when someone wanted to send something or do a remote execution, the UUCP system would call a neighboring computer. However, some systems couldn't dial out, so it was also possible for a neighbor to call in and poll to see if there was anything you needed to do. Files would go from one system to another using a variety of protocols.

UUCP still has utility in this era, and potentially in Amateur Radio content distribution over Amateur Radio networks, for several factors:

- It was effective in disseminating bulletins, files, etc. even with limited information about the entire network. A UUCP node only had to know about its nearest neighbors and the dissemination protocol was simple: "Got this file? No? Here it is." UUCP was pretty advanced; for example if a file was marked to expire at a future date (such as an announcement of a meeting), a host wouldn't attempt to propagate it.
- It accommodated low speed communication.
- It accommodated intermittent connectivity.
- In this era, with cheap compute and storage, and ample connectivity, a UUCP node can be an individual user station.
- UUCP is very well documented and standardized, and unlike the Amateur Radio Packet Radio Bulletin Board forwarding system(s), it's interoperable between Amateur Radio connectivity and Internet systems.

From my limited understanding, FidoNet shares these attributes and thus is also potentially usable for Amateur Radio content distribution over Amateur Radio networks. The primary difference between the two is that UUCP was developed on UNIX, and FidoNet was developed on personal computers.

APRS is NOT "Worthless"

Post publication Update *- The title (and URL) of this article was changed. New title (and URL) is:*

APRS Demystified: The Versatile Tool for Modern Amateur Radio

Jay Mottern DV7GDL on the how.aprs.works blog sponsored by the APRS Foundation:

> This is taken from a presentation I did at my amateur radio club's annual general membership meeting and Christmas party in Cebu, Philippines, on 6 December 2024, in front of over 30 members. There is a list of APRS and related links at the end that you can explore.
>
> **What is APRS?**
>
> APRS stands for Automatic Packet Reporting System (not "position reporting.") It was developed by Bob Bruninga WB4APR (SK) while he was a senior research engineer at the United States Naval Academy in the 1980s, using an Apple II computer, for the purpose of tracking Navy ships at sea. It has since evolved into much more than a mere location-tracking system.
>
> What APRS is now is a tactical, real-time information sharing and communications system that provides situational and spatial awareness of your immediate local area. It lets you know about everything happening or of interest near you. It also allows both local and global communications via text messages. It provides access to much more information via queries and responses to and from information servers and access to gateways to other services. All of this takes place on your radio's display, although you can also employ a cell phone (mobile) or tablet to get a visual representation of everything overlaid on a map. Bob Bruninga said, "The goal is communications and local info[rmation] updates, not just vehicle tracking."

I learned of this article from a post by Jeff Hochberg W4JEW (APRS Foundation President) on the aprsfoundation email list:

> Folks - I'm doing a little happy dance over here. I wish you could see it!
>
> We've had a flurry of interest from hams that want to contribute content to How APRS Works.
>
> Most of us have other commitments, whether family, work or otherwise, so we fully understand the desire but do not have the time to do it.
>
> Jay (DV7GDL) wrote what I think is a phenomenal post that I just published on the site!
>
> APRS is APRS is NOT "Worthless": https://how.aprs.works/aprs-is-not-worthless

> If you, or anyone you know, would be interested in contributing to How APRS Works, please get in touch with us via the Contact Us link. We may take a little while to reply, but we will respond!
>
> I'm just wrapping up some documentation for anyone wanting to publish content to the site to make it as easy as possible for contributors.
>
> The way we get the word out about APRS is through current, accurate, and easy-to-understand content! The Foundation cannot do it all by ourselves. We need a few more people like Jay posting regularly (or as often as possible).

It's slightly puzzling why DV7GDL chose that title, and then didn't actually explain the "worthless" reference.

Post publication update:
In a private email, a Zero Retries reader explained that the "worthless" reference from the article was probably in response to a particular YouTube video that pronounced APRS as "worthless"; I won't dignify that video with the actual title or a link or a mention of the YouTube channel. Such pronouncements are just clickbait.

This is a good, detailed intro article on APRS and what's best about it is that it's a *contemporary* article written about APRS in *this* era, with no outdated references to old hardware or practices that are so common in archival articles about APRS. It's great that material like this is being published under the stewardship of APRS Foundation. Kudos to DV7GDL and APRS Foundation!

Leave a comment

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Join the *Fun* on Amateur Radio

If you're not yet licensed as an Amateur Radio Operator, and would like to join the fun by *literally having a license to experiment with radio technology*, check out
Join the Fun on Amateur Radio for some pointers.

Zero Retries Frequently Asked Questions (FAQs) — In development 2023-02.

Closing the Channel

In its mission to highlight technological innovation in Amateur Radio, promote Amateur Radio to techies as a literal license to experiment with radio technology, and make Amateur Radio more relevant to society in the 2020s and beyond, Zero Retries is published via email and web, and is available to everyone at no cost. Zero Retries is proud *not to participate* in the Amateur Radio Publishing Industrial Complex, which hides Amateur Radio content behind paywalls.

My ongoing ***Thanks*** to:

- Tina Stroh KD7WSF for, well, *everything!*
- ***Annual Founding Members*** **who generously support Zero Retries financially:**
  Founding Member 0000 - Steven Davidson K3FZT (Renewed 2024)

  Founding Member 0001 - Randy Smith WU2S (Renewed 2024)
  Founding Member 0002 - Chris Osburn KD7DVD (Renewed 2024)
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  Founding Member 0006 - Todd Willey KQ4FID (Renewed 2024)
  Founding Member 0007 - Merik Karman VK1DF / VK2MKZ (Renewed 2024 *with two Founding Member subscriptions!*)
  Founding Member 0008 - Prefers to Remain Anonymous 14 (Renewed 2024)
  Founding Member 0009 - Prefers to Remain Anonymous 19
  Founding Member 0011 - Rick Prelinger W6XBE (New 2024)
  Founding Member 0012 - Ryan Tolboom N2BP (New 2024)
- Numerous Annual and Monthly subscribers who also generously support Zero Retries financially!

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- The *most* effective way to support Zero Retries is to simply mention Zero Retries to your co-conspirators that are also interested in knowing more about technological innovation that is occurring in Amateur Radio and encourage them to become a fellow subscriber.
- One particularly effective method of promoting Zero Retries is to add a mention of Zero Retries to your QRZ page (or other web presence) and include a link:

  https://www.zeroretries.org
- If you'd like to financially support Zero Retries, becoming a paid subscriber is *greatly* appreciated and helps offset expenses incurred in publishing Zero Retries. Paid subscriptions for Zero Retries are *entirely optional*, as explained in this special issue of ZR:
  Zero Retries Administrivia - Activating Payment Options.

These blogs and newsletters regularly feature Zero Retries Interesting content:

- Dan Romanchik KB6NU mentions "Zero Retries Interesting" topics so regularly on his blog (that I otherwise wouldn't know about) that I've bestowed on him the honorific of Pseudostaffer.

- Jeff Davis KE9V also mentions “Zero Retries Interesting” topics so regularly on his blog (that I otherwise wouldn’t know about) that I’ve bestowed on him the honorific of Pseudostaffer.
- Amateur Radio Weekly by Cale Mooth K4HCK is a weekly anthology of links to interesting Amateur Radio stories that often feature “Zero Retires Interesting” topics.
- Experimental Radio News by Bennet Z. Kobb AK4AV discusses (in detail) Experimental (Part 5) licenses issued by the US FCC. It’s a *must-read-now* for me!
- RTL-SDR Blog - *Excellent* coverage of Software Defined Radio units.
- TAPR Packet Status Register has been published continuously since 1982.
- Hot Iron - The Journal of the Constructor’s Club is a delightful quarterly newsletter.
- Other Substack Amateur Radio newsletters recommended by Zero Retries.

These YouTube channels regularly feature Zero Retries Interesting content:

- HB9BLA Wireless by Andreas Spiess HB9BLA
- KM6LYW Radio by Craig Lamparter KM6LYW (home of the DigiPi project)
- Modern Ham by Billy Penley KN4MKB
- Tech Minds by Matthew Miller M0DQW

These podcasts regularly feature Zero Retries Interesting content:

- Store and Forward - a podcast about the past and future of amateur radio, by Kay Savetz K6KJN (curator of the Digital Library of Amateur Radio and Communications) and Steve Stroh N8GNJ (Editor of Zero Retries).
- Ham Radio Workbench by George Zafiropoulos KJ6VU (and friends)
- Foundations of Amateur Radio by Onno Benschop VK6FLAB

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Zero Retries (N8GNJ) is on Mastodon — n8gnj@mastodon.radio — just click:

Zero Retries / N8GNJ on Mastodon

Zero Retries (N8GNJ) is also on Bluesky — @n8gnj — just click:

Zero Retries / N8GNJ on Bluesky

Email issues of Zero Retries are “instrumented” by Substack to gather basic statistics about opens, clicking links, etc.

More bits from Steve Stroh N8GNJ:

- **SuperPacket blog** — *Discussing new generations of Amateur Radio Data Communications - beyond Packet Radio (a precursor to Zero Retries)*
- **N8GNJ blog** — *Amateur Radio Station N8GNJ and the mad science experiments at N8GNJ Labs in Bellingham, Washington, USA*

Thanks for reading!
Steve Stroh N8GNJ / WRPS598 (He / Him / His)
These bits were handcrafted (by a mere human, not an Artificial Intelligence bot) in beautiful Bellingham (The City of Subdued Excitement), Washington, USA, and linked to the Internet via **Starlink *Satellite* Internet Access**.

2025-01-17

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